

# **FAULT RECOVERY RECOMMENDATION**

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and**

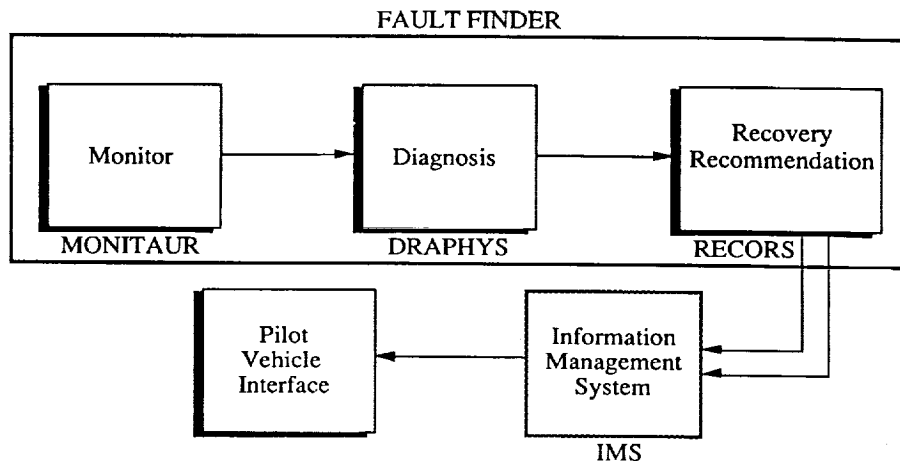
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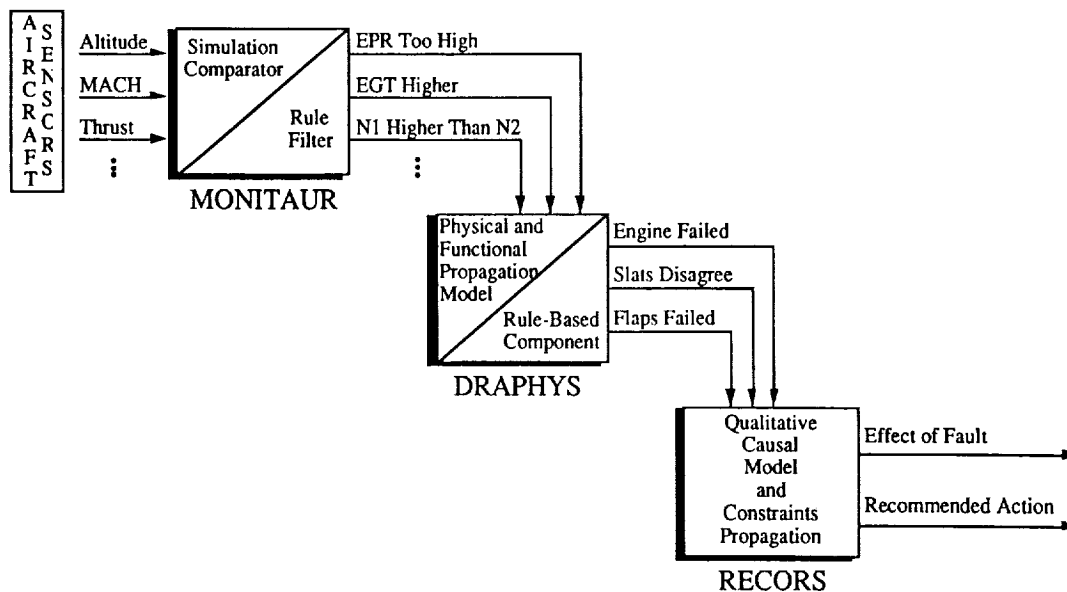


# SYSTEM INTEGRATION CONTEXT FOR THE RECOVERY RECOMMENDATION SYSTEM (RECORS)

**System Goal:** To provide intelligent aiding for monitoring, diagnosis and response to aircraft system failures.



## DATA FLOW CONTEXT FOR RECORS



# **GOALS OF RECOVERY RECOMMENDATION SYSTEM (RECORS) ARE SITUATION ASSESSMENT AND RESPONSE AIDING DURING EMERGENCIES**

## **Method:**

- **Predict effects of faults on future system behavior**
- **Perform reasoning to aid the time-stressed and/or capacity limited flight-crew to suggest response to faults**
- **Predict consequences of recommended actions and advise crew**

## **RECORS: MODEL-BASED SITUATION ASSESSMENT/RESPONSE AIDING**

### **Current Status:**

- **Functions in a help mode, rather than autonomous mode**
  - **pilot is in the Loop**
  - **pilot has Final Authority**
  - **explanation of Reasoning and Displays are Important**
- **Uses a causal model of the aircraft and the flight domain**
- **Reasons at multiple levels of abstraction**
- **Predicts the effects of aircraft system failures on flight profile**
- **Suggests responses in emergencies**

## **. . . RECORS**

### **Planned Development:**

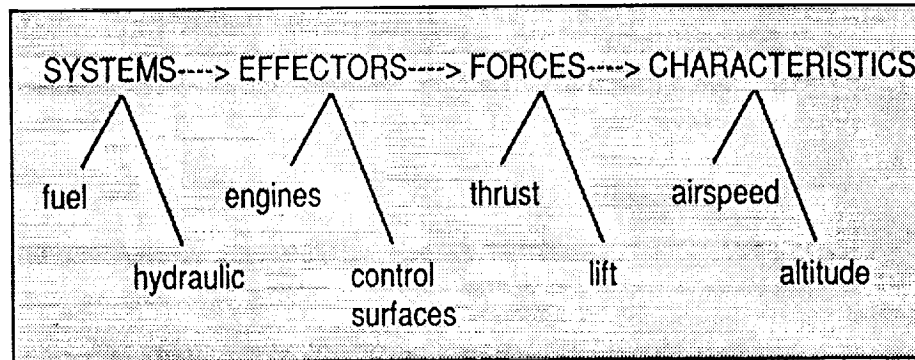
- **Help identify faults based on their effects on the system**
- **Help make up for lack of sensor data by inferencing**
- **Predict long-term effects of actions to help in response selection**

## **RECORS: CAUSAL MODEL**

- **Model implemented within Object-Oriented, Frame-Based representation formalism**
- **Model consists of objects representing:**
  - **aircraft sub-systems**
  - **effectors**
  - **forces acting on the aircraft**
  - **flight characteristics**

## CAUSAL MODEL (cont)

- Represents both the taxonomic and the causal relationships among the objects



### RECORDS: MULTIPLE LEVELS OF ABSTRACTION

- Two orthogonal types of abstraction exist in the model: taxonomic and causal

- Taxonomic ("IS-A" relationship)

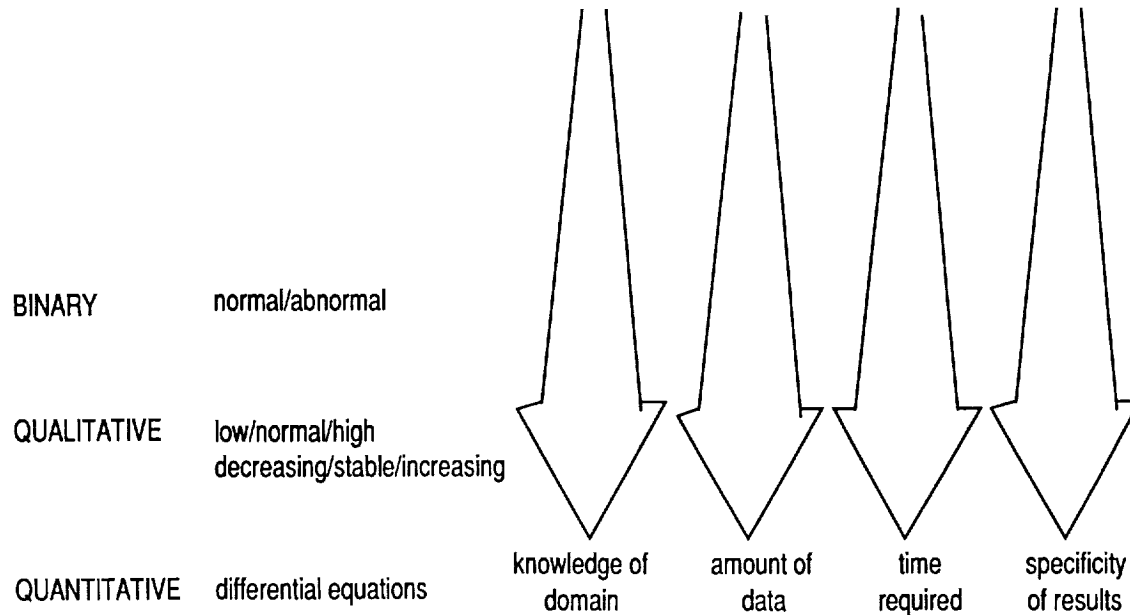
Taxonomic abstraction consists of the different levels of the model hierarchy

- Causal: causal relationships among model objects expressed at binary and qualitative levels (AFFECTS and AFFECTED-BY relationships)

Causal relationships are represented at both binary and qualitative levels at each level in the object taxonomy

- Other planned abstractions include partonomy and physical location relations

## MULTIPLE LEVELS OF ABSTRACTION



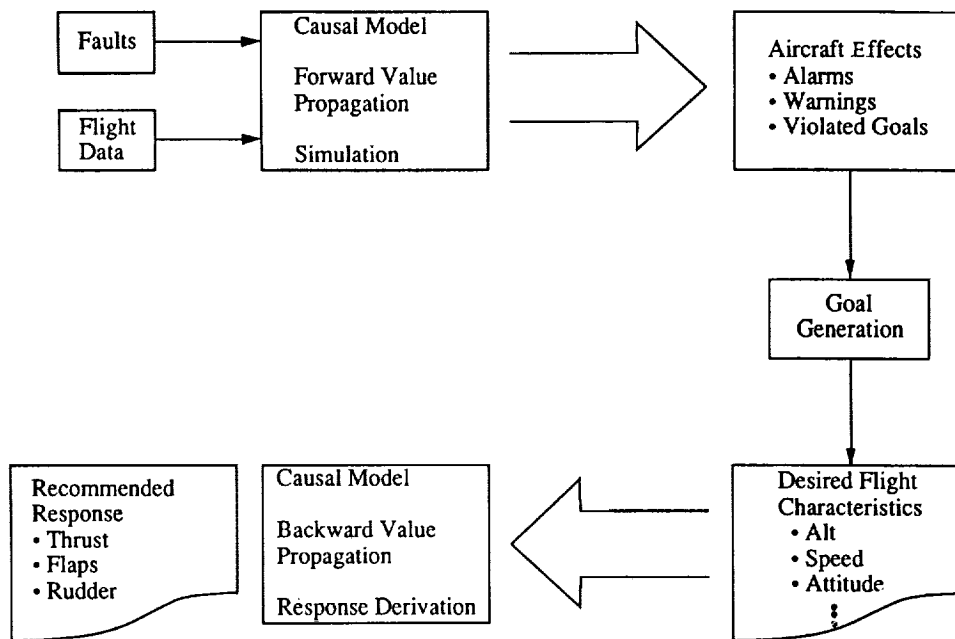
## RECENT DEVELOPMENTS

- Causal Model Editor
- Subsystem Modeling
  - Requires the Representation of various types of Causal Relations
  - Different Temporal Propagation Delays Exist Along the Causal Links
  - Requires Use of Different Causal Contexts
  - Specialized "Device" Models
- Representational Formalism Modified to Reflect these Requirements
- Simulation Algorithm Modified to Reflect These Requirements
- Time Representation Included in terms of Delays Along Causal Links
- Reconfigurable Interface

## FUTURE DIRECTIONS

- **Explanation**
  - Display Format for Recommendations and Aircraft Effects
  - Visual and Textual Explanation of RECORS' Reasoning
- **Verification and Validation**
  - Determine How System Effectiveness Varies with
    - fault type
    - emergency type
    - display design
    - crew experience
  - Verify Model Function
  - Validate Against Known Accident Responses
- **Evaluation**
  - Test Pilot Acceptance in Cockpit Simulation

## RECORS INFERENCE CYCLE

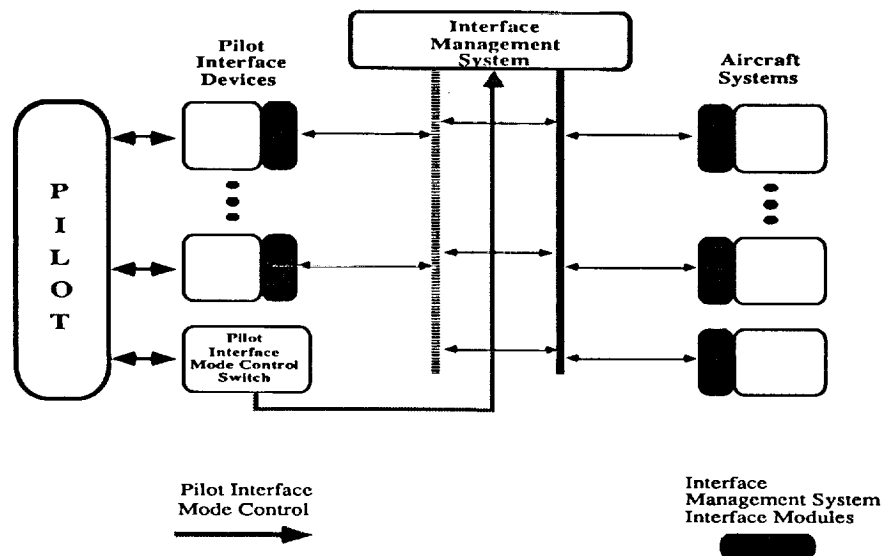




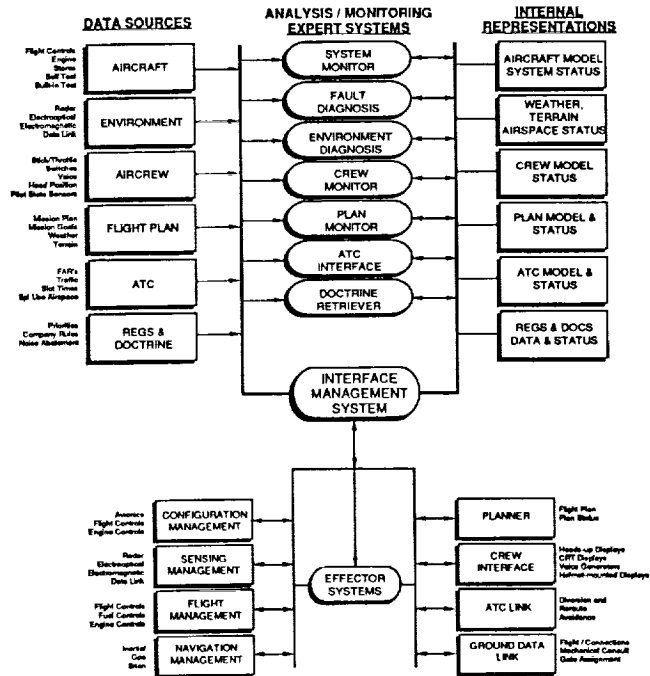
# RECORDS IMPLEMENTATION

- Version I: Implemented in the KEE development environment on a Symbolics 3600
- Version II: Implemented in Zeta LISP Using an Object-Oriented, Frame-Based Language on a Symbolics XL400

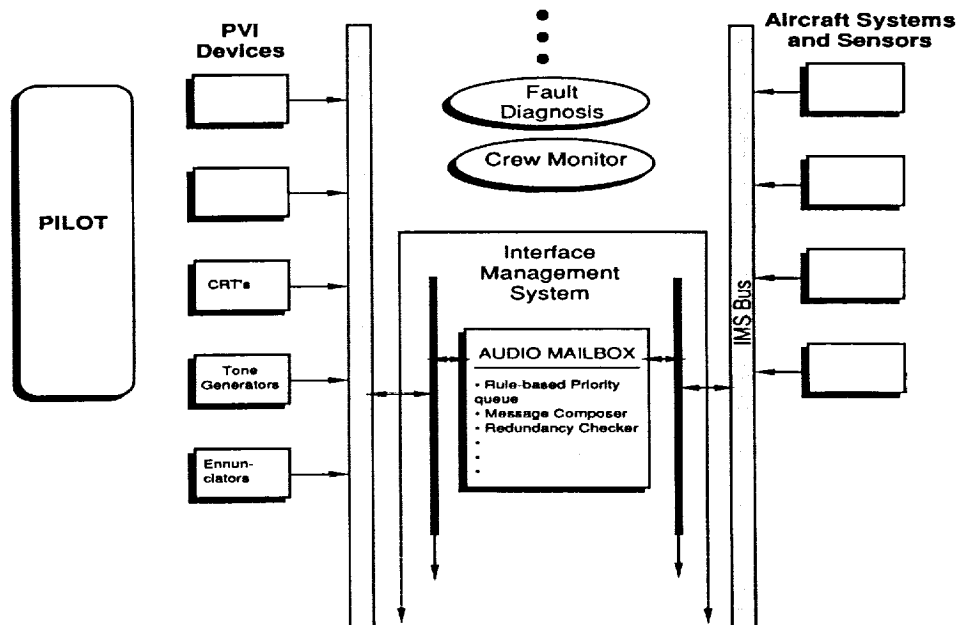
**THE INTERFACE MANAGEMENT SYSTEM MANAGES  
THE FLOW OF INFORMATION AND THE DIALOGS  
BETWEEN THE SYSTEMS AND THE PILOT**

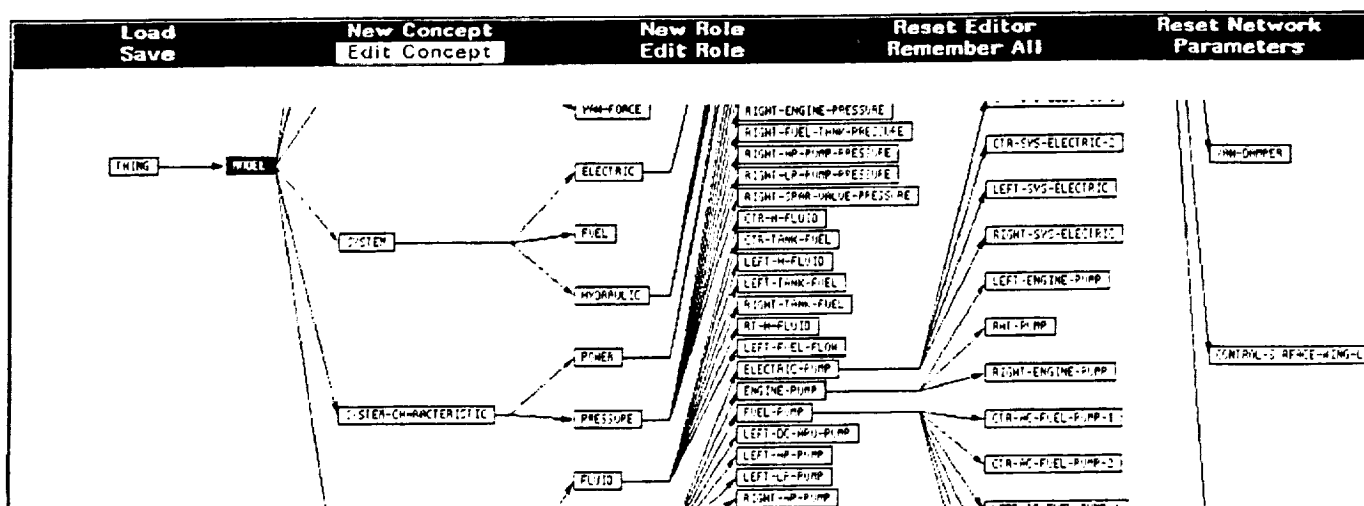


## OVERALL A3 ARCHITECTURE



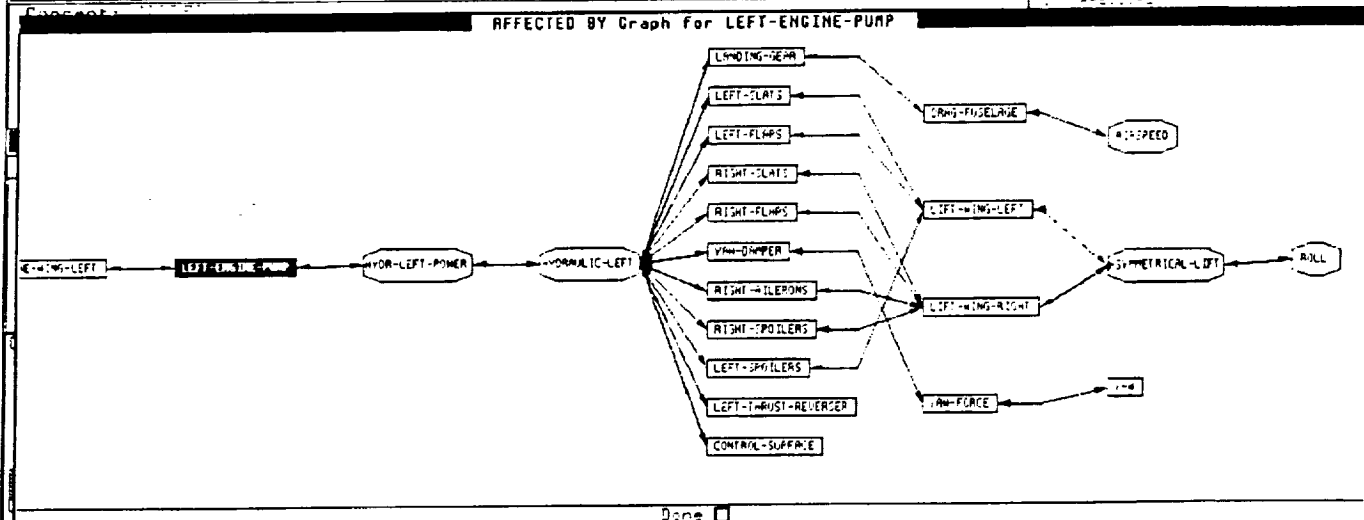
## AUDIO MAILBOX ARCHITECTURE AND INTERACTIONS WITH IMS





Abstractions and Specializations of MODEL

Flavorize Copy New Child View Kill Pop Stack Revert Remember NO: MODEL  
: PREC: PE



Left and hold: pan; Middle: speed pan; Right: menu of other graph operations.  
To see other commands, press Control, Meta or Shift.

[Fri 29 Sep 83 04:25] Eva

CL PF:

User Input

GRAPH

ORIGINAL PAGE IS  
OF POOR QUALITY

